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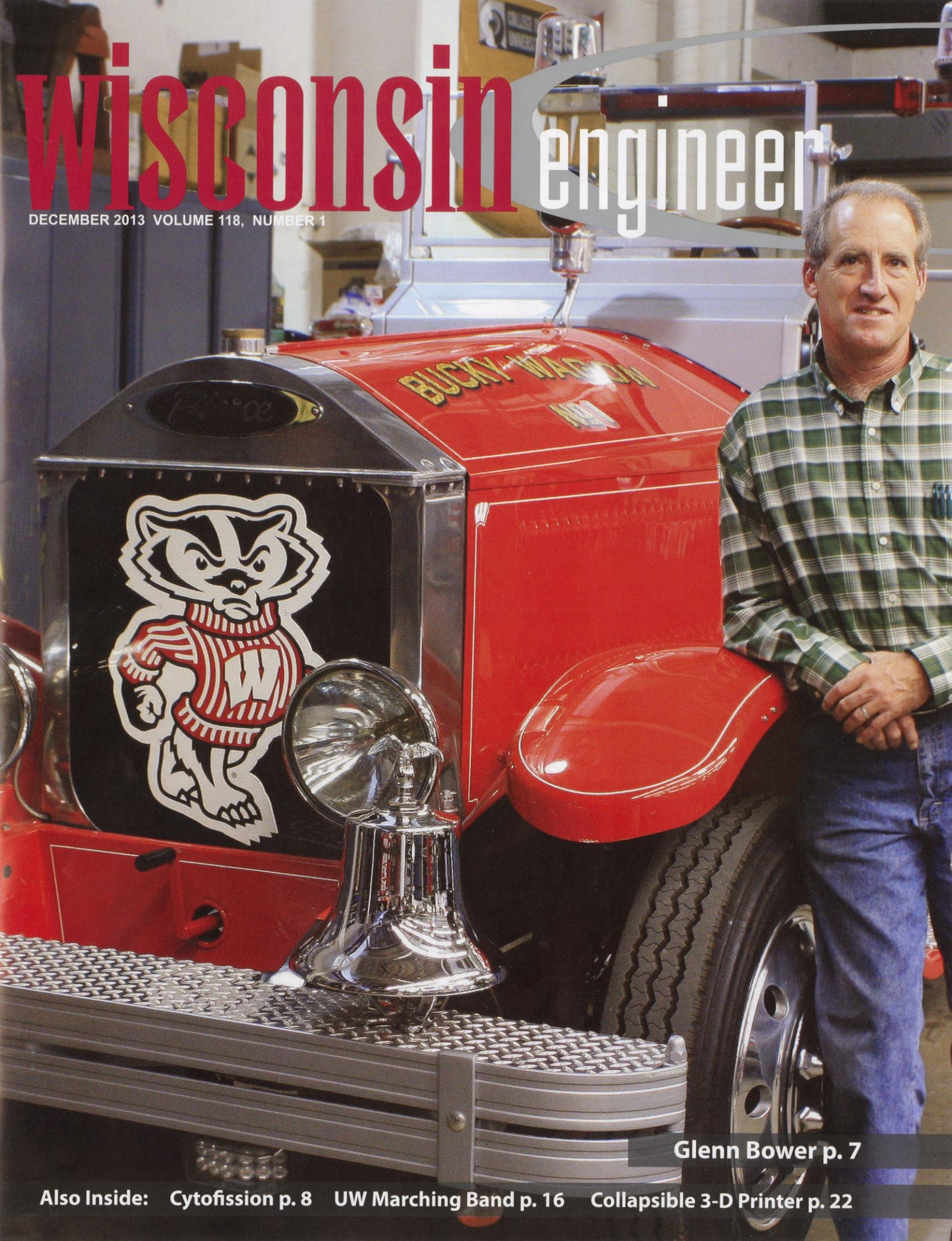

wisconsin engineer

DECEMBER 2013 VOLUME 118, NUMBER 1

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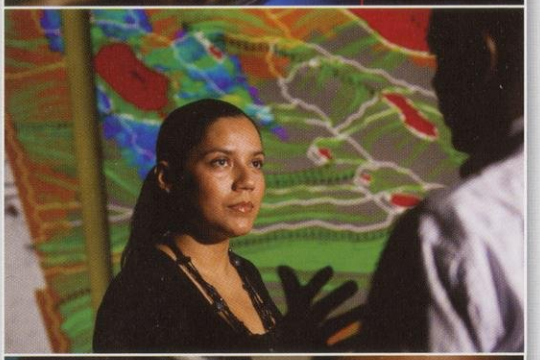

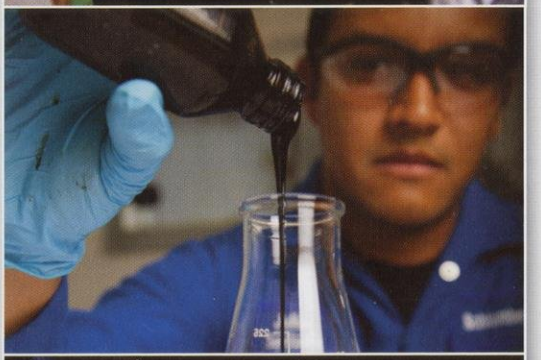

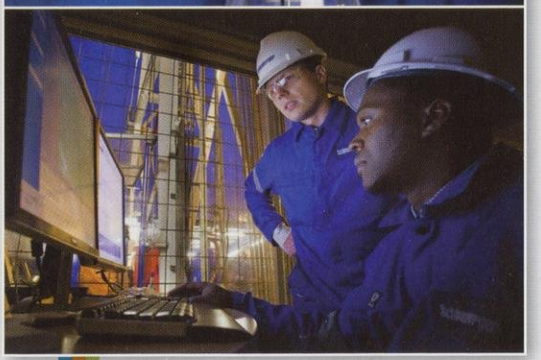

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Published by the students of the University of Wisconsin-Madison VOLUME 118, NUMBER 1 DECEMBER 2013

General

Cover photo by Sommer Ahmad

Commentary

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This Issue is Dedicated to:

Victoria Yakovleva, Editor-in-Chief and writer who helped the magazine grow into what it is today, and Eyleen Chou, an energetic photographer who was always looking to help others. Both of these astonishing women passed away this fall and will be greatly missed.

Wisconsin Engineer Staff

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Student Government

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From Freshman to Super Senior

An Editorial
by Elly Underwood

On move-in day freshman year, my mom, younger sister and I unloaded the boxes from our family car into my new dorm room. It was only a matter of time before the worst freshman mistake ever was realized: where were all the boxes of my clothes? Still at home, in Minnesota. Next, a few short weeks after move-in, my first college exam in calculus one resulted in a D and lead me to think, "If I can't even pass calc one, how will I ever be able to complete a degree at this top-ranked engineering school?!"

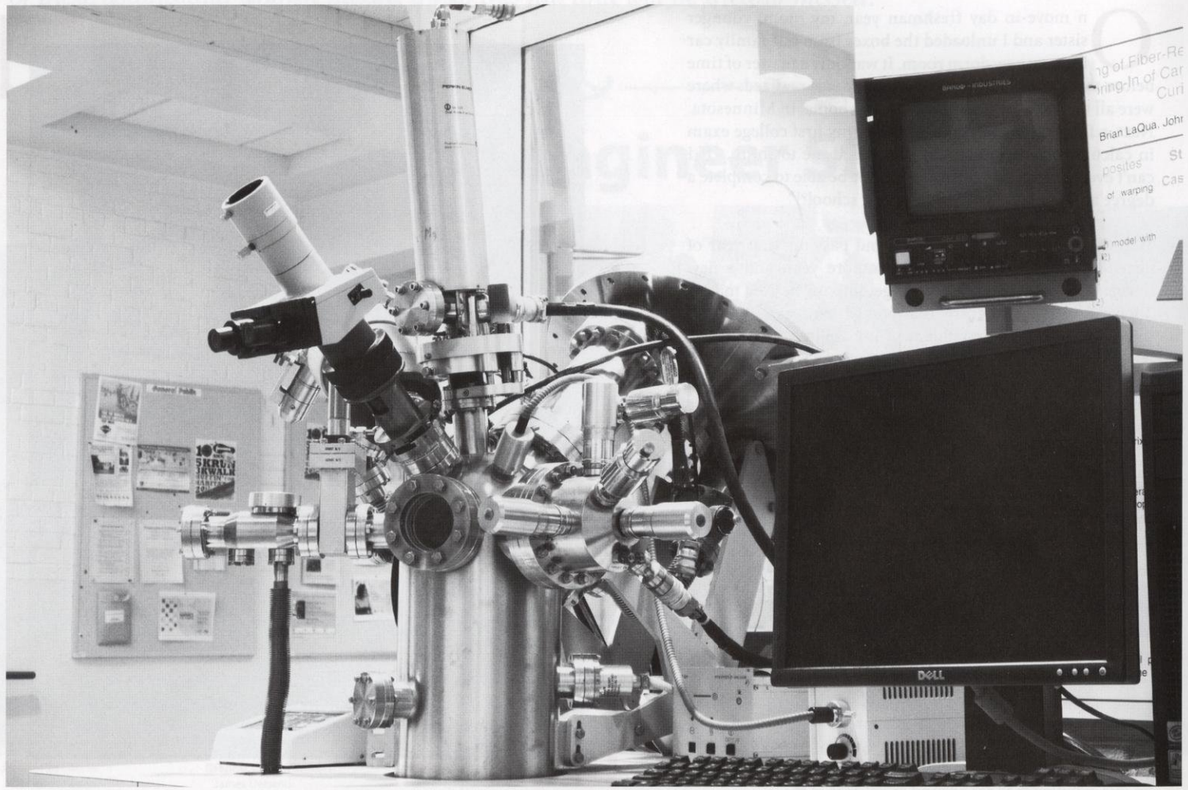
While I was able to buckle down and pass my first year of general courses, soon it was sophomore year, and a new uncertainty arose: what if I didn't get into my desired major? Then it was junior year; by that point I had passed enough difficult classes to be confident in my ability to handle the coursework, but once again a new stressor emerged as I tried to find an internship or co-op. In the blink of an eye, I am on track to graduate within the next semester. While I have gained some responsibility compared to my former freshman self who forgot all of her clothes when moving into the dorms, my top concerns have shifted from passing classes and finding jobs to trying to make the most out of my last few months in college.

It is enjoyable for me to reflect on the past four years I have spent at UW-Madison. Once a student who was worried about whether or not she would make it, I have become a student who has had internships and a co-op, traveled overseas, and even had the opportunity to tour an oil rig! The education I have received in the College of Engineering will certainly empower me to go out into the real world after I graduate and be a positive contributor to society. After my experiences at UW-Madison, I would strongly encourage fellow Badgers to enjoy every moment and to constantly look for new opportunities on our campus; they are around every corner. WE

COLLABORATION is the KEY to...

MATERIALS INNOVATION

UW-Madison makes its contribution to speed up the discovery and commercialization of new materials.



A High-Tech Microscope located in the Materials Science Engineering Building

The advancement of humanity has relied on the discovery of materials ever since the Stone Age. Even in modern times, new materials show enormous potential, but a major problem is the lapse in time between discovery and technological application. Unsatisfied with the two decades that discovered materials often take to hit the market, President Obama announced the Materials Genome Initiative (MGI) in June of 2011 with the goal of doubling the nation's speed of materials innovation. This past June, UW-Madison joined this effort by announcing that the Wisconsin Materials Institute (WMI) would be created to facilitate greater interaction between disciplines and ultimately increase the speed of materials innovation.

WMI is built around three main ideas: novel computational modeling, the discovery of new characterization and synthesis techniques and the organization and accessibility of data. The unification of these ideas will require the expertise of leaders from many fields, including materials science, math, statistics, engineering and computer science. "We have the power to store and manipulate [data] now unlike ever before," says Dane Morgan, associate professor of materials science and engineering. "As we develop materials data, we want to make it available, accessible, mineable and integrated with the computational tools." If the massive amounts of data from national, or even international, materials research and testing are shared, redundant activity could be eliminated. The United States could finally achieve President Obama's coveted speed boost.

"Imagine that you have access to all of the characterization that has been done previously, including all the raw data on similar types of systems and state-of-the-art tools for analyzing it, and it is all free and online."

- Dane Morgan

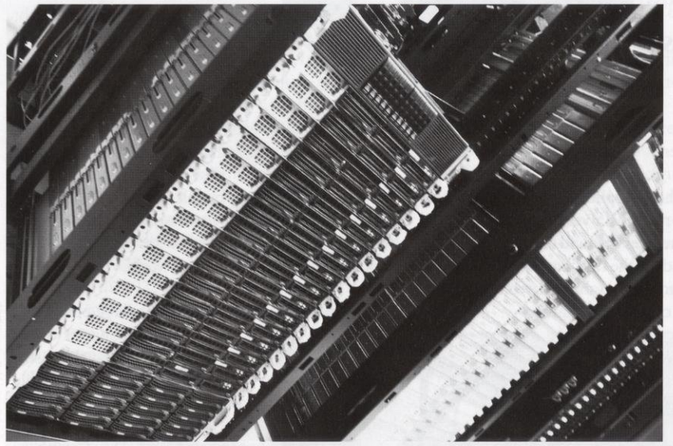
Dane Morgan is co-directing WMI with Thomas Kuech, professor of chemical and biological engineering. They have been hard at work getting WIMII up and running, managing the initial investment of $5 million from the college of engineering and planning activities that will improve the interaction between relevant fields.

This funding includes a budget for new equipment. The college of engineering recently purchased a Focused Ion Beam (FIB), a device used to shape materials on a microscopic level. One major application for a FIB is in the fabrication of semiconductors, a booming field in materials science. The hope is that in time, equipment such as the FIB can be utilized remotely so that researchers across the nation can gather materials data without the hefty investment.

Before this cooperation can work, WMI must make sure that UW-Madison is working at it's best internally. One plan currently in the works is a workshop for next year. "The workshop will help bring together people from relevant fields to start to understand what some of the issues are with data collection, analysis and mining," Kuech says. This will be important for the future direction of WMI, which will use its resources to begin to address these issues and improve efficiency for the UW-Madison.

The cooperation doesn't stop there, though. UW-Madison, along with Georgia Tech and the University of Michigan, will be leading an MGI supported effort to enhance national communication for materials research. The network is envisioned to include numerous institutions, companies and even individuals that will work together to increase the pace of materials innovation. With the new computation and data organization techniques that result from these partnerships, the United States could become much better integrated in its materials research efforts. "Imagine that you have access to all of the characterization that has been done previously, including all the raw data on similar types of systems and state-of-the-art tools for analyzing it, and it's all free and online," says Morgan.

While the WMI is just starting up, its precise goals and clear direction show a great deal of promise. By addressing data needs and initiating a larger cross-disciplinary discussion, UW-Madison and the rest of the United States can create new strategies for innovation. In time, these can be implemented and fully integrated into the academic and commercial spheres. WMI will be a key player in the creation of this new nation at the pinnacle of efficiency. New materials will reach industry faster than ever before, impacting numerous fields. Consumers will begin seeing products with new semiconductors, fuel cells or even synthetic tissues before they even know they need them. WE



Additional servers will be crucial to the storage of increasing amounts of materials data

Written by: Robby Panighetti

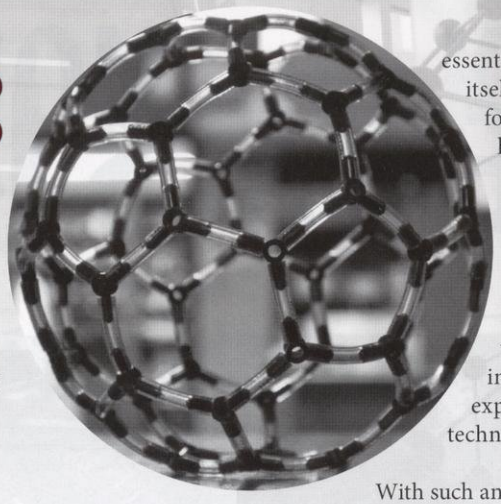
Photography by: Mitch Stamp

Design by: Jason Wan

Fullerenes:

Pervasive Structures of the Nanoworld

A description of carbon nanostructures and their applications in technology, research and play.



While the term "bucky ball" might scream Badger athletics, it actually refers to buckminsterfullerene, a hollow sphere of 60 carbons that, ironically, is geometrically identical to the classic hexagon and pentagon soccer ball. Bucky balls are the most abundant of the fullerene family, which is a group of carbon allotropes that take the form of hollow spheres, tubes and ellipsoids. The unusual name is a tribute to Buckminster Fuller, the 20th-century architect famous for geodesic domes, spherical structures based on overlapping circles. (Think Spaceship Earth at Epcot, Walt Disney.)

Of late, the fullerenes and flat carbon sheets called graphene have been of great interest within nanotechnology, as they hold great potential in superconductivity—when a conductor exhibits zero electrical resistance, minimizing energy loss—and material strength, among several other applications. According to Dr. Andrew Greenberg, Coordinator of Education and Outreach for the Institute for Chemical Education and Nanoscale Science and Engineering Center, graphene can act as a superconductor at nearly room temperature, a huge boon since most substances act as superconductors only near absolute zero. This could have an enormous impact on computing and electronics in the future, since it is currently unfeasible to attain temperatures low enough to invoke superconductivity in standard materials.

As for the material strength of fullerenes, rolled up sheets of graphene called nanotubes have been found to be over a hundred times stronger than steel, a result of extensively shared electrons between carbon atoms.

While super-strength has innumerable applications, the unique hollow structures of fullerenes may soon be employed in pharmaceuticals and health care as well. Dr. Ralf Wehlitz, who researches bucky balls and related fullerenes at the UW-Madison Synchrotron Radiation Center (SRC) in Stoughton, WI, explains that fullerenes can be endohedral, meaning they contain molecules or metals within their otherwise hollow centers. This means that these molecules could act as antioxidants removing free radicals, and that they could deliver drugs with molecular precision.

Even with all these applications, Dr. Greenberg notes that there remains a yet untapped potential within these structures that will only be realized by better understanding the fundamental processes at the nanoscale, a middle ground between the worlds of quantum and classical mechanics.

Photo by Libby Dowdall

First, second and third grade students from the Children's House Montessori School in Dundee, Ill. play on the Carbon Playground structures at the Discovery Center Museum in Rockford, Ill.

Working to understand just that, Dr. Wehlitz studies double-ionization, the removal of two electrons by one photon. Using radiation from electrons accelerated in SRC's storage ring, he ionized gaseous bucky balls, forming +2 or +1 ions. Since acceleration in an electric field is proportional to the charge on the particle, particles with a +2 charge would reach the detector before particles with a +1 charge. Dr. Wehlitz used this fact to measure the ratio of doubly-ionized +2 bucky ball ions to +1 bucky ball ions that were formed.

In most molecules, this ratio is consistent across different energies of light, but Dr. Wehlitz surprisingly found that this ratio varied in bucky balls. He and his research group determined that these variations corresponded to the geometry within the molecule. The energies of light that maximized the +2 ion to +1 ion ratio gave wavelengths that were nearly equal to carbon-carbon bond lengths, the diameter of the entire bucky ball, and other similar dimensions on the molecule. The variation in the ion ratio essentially depicted the molecule itself. Now, Dr. Wehlitz is moving forward to test if this property holds true in other fullerenes, like the elliptical carbon-70 and endohedral molecules.

Although Dr. Wehlitz's research is more fundamental in nature than applied, such work will provide vital insight into nanoscale processes, expanding the horizon of nano-technological applications.

With such an exciting field as nanotechnology, student-famous chemistry lecture demonstrator Jim Maynard once posed the question: "How do we expose young people to it?" What he, Dr. Greenberg, chemistry Professor John Moore and Dr. Amanda Jones came up with was a fun way to immerse children in the nanoworld.

Maynard had previously built the large bucky ball that sits by the Charter Street entrance to the chemistry building. One day while discussing what they could do with such large models, Maynard and Dr. Greenberg both realized that a carbon themed playground would the perfect platform to teach chemistry to young students.

With the help of several undergraduates, Maynard began fabrication using a scale of 27.5 inches per angstrom, a factor of about 7 billion. Using the same equipment crystallographers on campus use to build their small, hand-held models, Maynard cut and drilled with such accuracy as to even account for the slight deformation caused by a tether molecule used in crystallizing the bucky balls.

In total, Maynard built a graphene sheet, a carbon nanotube and a bucky ball for children to climb on. But the really unique feature of the playground, located at the Discovery Center Museum in Rockford, IL, is that it is connected to a huge resource of interactive scientific activities and information for children to explore.

The project took about three years to complete, and now it is one of the most popular exhibits at the museum. And its popularity will surely endure, as the next generation of nanoscale scientists continues to climb and clamber through the world of carbon. WE

Written by: Thejas Wesley
Photography by: Matt Henricks
Design by: Michael Khor

Professor Profile:
Glenn Bower

(If you love cars, You ought to meet this guy!)

Once an iconic vehicle that ferried athletes and cheerleaders around the campus of UW-Madison since 1971, the Bucky Wagon was retired to a campus garage in 2009. The vehicle was too old, hard to control and was not able to carry the load of many people. While many thought that the great reputation of the Bucky Wagon was over, it was just another opportunity for the students and staff of the College of Engineering to perform their magic. They did not just merely fix the vehicle, they revamped the 1932 model, making it an eco-friendly vehicle with its traditional exterior features intact. After two years of hibernation, the Bucky Wagon proudly made its way through the crowds of the 2011 Homecoming Parade, regaining its past reputation. The new all-electric motor in the Bucky Wagon is the work of Glenn Bower, professor of mechanical engineering at UW-Madison, and his students.

"If I claim that I do not want to teach the auto projects anymore, I basically would have to leave this university... it would be too hard to not be involved."

Born and raised in Richland Center, Wisconsin, Bower was always interested in engines. Even at a young age, his passion for vehicles was extremely apparent. During high school, he played around with vehicles whenever he had time. "I was rebuilding tractors and cars and making go-carts, basically anything that had an engine," says Bower.

While studying mechanical engineering as an undergraduate at UW-Platteville, he was involved in many different engineering projects. In addition, Bower worked a co-op with Paper Industries in Green Bay, where he independently managed a $6 million-dollar project. After gaining some experience in engineering, Bower knew what he wanted to do for the next thirty years and decided to go to graduate school at UW-Madison. During his graduate and Ph.D. work, he was involved with the Engine Research Center, one of the world's leading research centers of its type.

Today, Bower teaches a variety of courses in the mechanical engineering department, including senior design, internal combustion engines and the economics portion of ME314, rapid manufacturing. In addition, Bower is well educated on Computer Numeric Control (CNC), has taught thermodynamics and fluid dynamics courses and oversees thirty to sixty students working on independent projects each semester.

Bower is also one of the most actively involved faculty members in student organizations and is passionate about not only engines, but also guiding his students into their futures. Bower is a major contributor to the success of the UW-Madison vehicle teams. Under his guidance, the Baja team, which builds a prototype off-road RTV, has won two national championships and placed second two times at the SAE collegiate competitions in the last four years. Additionally, the Hybrid team has won five national championships in the last six years, the snowmobile team won the 2013 Clean Snowmobile challenge and the formula team consistently ranks high among other universities. "If I claim that I do not want to teach the auto projects anymore, I basically would have to leave this university, it would be too hard to not be involved," says Bower.

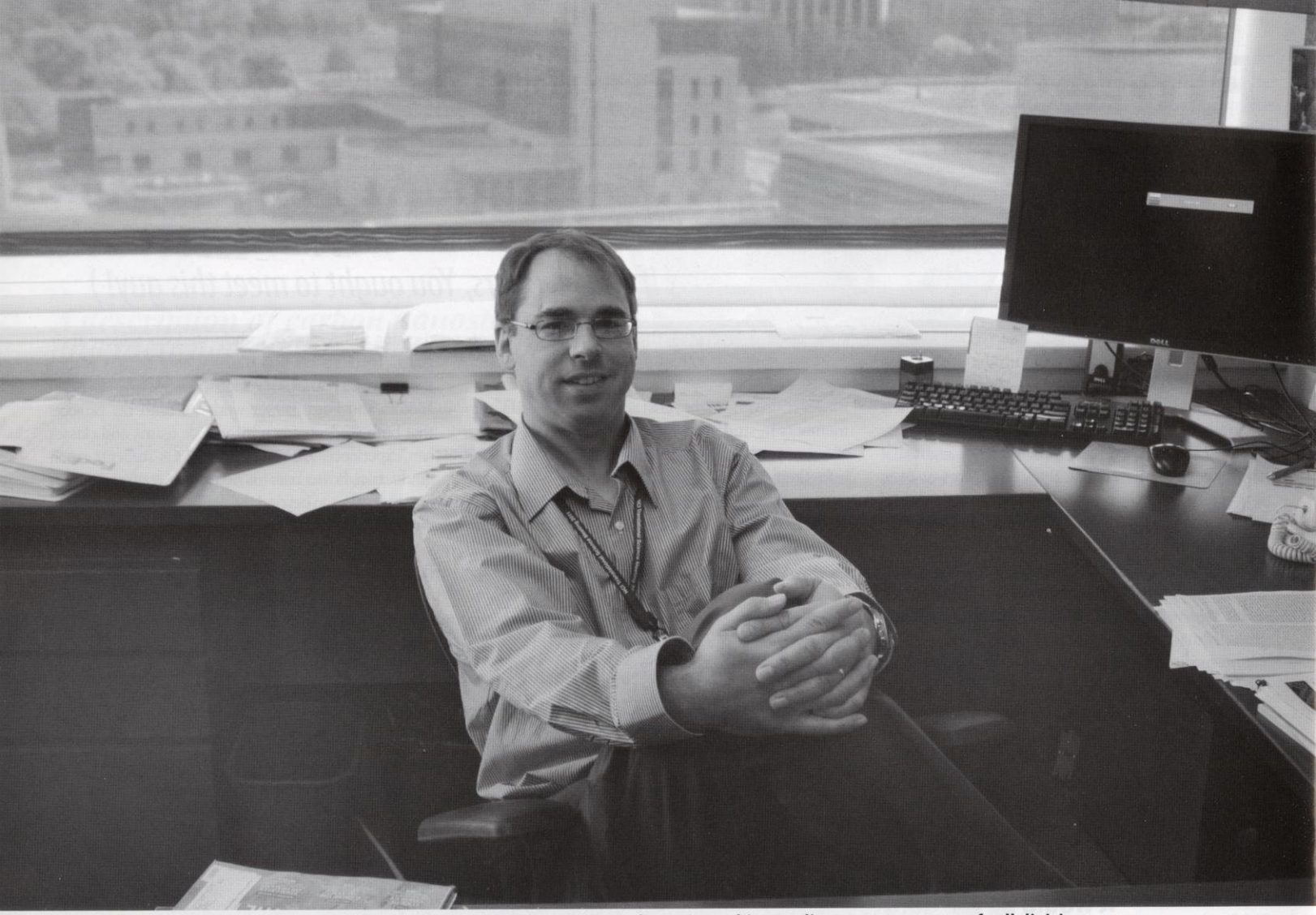
What Bower does as an adviser and mentor of the vehicle teams is not merely making sure that students are following safety measures in the auto shop. He uses his full resources to help students achieve their goals. Through his accumulated connections within the university and auto industries such as General Motors and Ford, Bower works to fund the projects that both students from his vehicle teams and classes can experience. Also, by the time his students reach graduation, Bower uses his network of contacts to push his students to go beyond the workshop, whether it is to pursue higher education or start a career.

It is clear how passionate Glenn Bower is about the UW-Madison vehicle teams and how close he is to his students, who he shares his office with. Frequently throughout the day, Bower's students go in and out of Bower's office, using a CAD station for their projects on the other side of his desk. When asked about the environment, Glenn replied, "I typically never shut the door... and I will not let anybody call me professor or doctor. I prefer them to call me by my first name." WE

With a passion for and comprehensive knowledge of the inner-workings of vehicles, Bower instructs Hybrid vehicle team members in the functions of various parts of the car.

Written by: Hanwook Chung

Photography by: Sommer Ahmad



Dr. Mark Burkard, an assistant professor of hematology-oncology at UW-Madison, is working to discover a new type of cell division

Cytofission

Dr. Mark Burkard, assistant professor of hematology-oncology in the department of medicine at UW-Madison and member of the UW Carbone Cancer Center, alongside his head researcher, Alka Choudhary, and other graduate students, have discovered a new type of cell division. Cytofission, as it is referred to, has the ability to return potentially cancerous cells back into normal, healthy cells. If applied correctly, cytofission could revolutionize the way cancer is treated.

This discovery was made in Fall 2012 while manipulating human cell division to create cancer-like polyploid cells, or cells with more than one set of chromosomes. To create the abnormal cells, the lab blocked the final stage of cell division, not allowing the cell to split. Surprisingly, many of the cells became normal ells with the correct number of chromosomes, while only a few remained as polyploids.

Cytofission has only been previously observed in slime molds, single celled, eukaryotic organisms commonly found on dead trees. Dr. Burkard believes that human cells have acquired the ability to perform this same type of cell division through evolution as means to prevent cancers. He believes that this could possibly be the reason why less people get cancer when they are under the age of 35 compared to those older.

This discovery, however, will likely not lead to a market drug used to prevent cancer. Since only 15 to 30 percent of all cancers come from

a piece of the puzzle

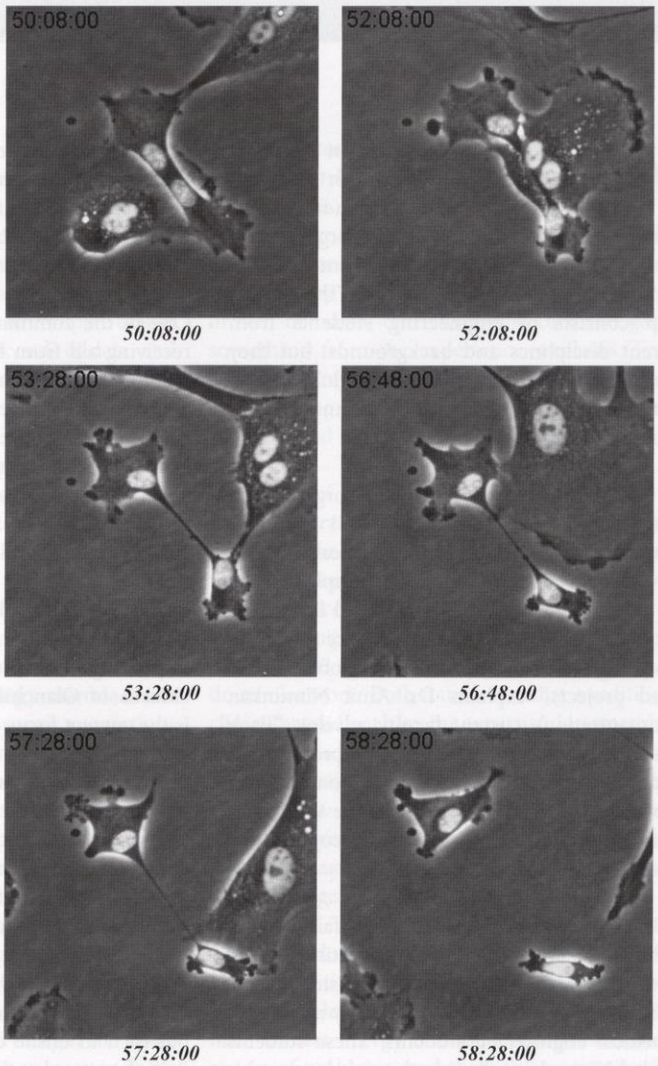
New type of cell division could lead to a cancer treatment breakthrough.

polyploid cells, the idea of having hundreds of thousands of healthy people taking a drug regularly to prevent a specific type of cancer would be out of the question. Dr. Burkard stated that although the discovery itself "will not get a product to market," he learned that "There is more to the human biology than we had anticipated. And things that we learned twenty years ago, in simple molds, are indeed relevant." Applying the knowledge gained from this discovery may lead to a new cancer treatment in the future. During a follow up study, after the discovery of cytofission, the lab took the cells that did not undergo the cytofission and began to experiment on them, testing to see if there was a way to return the cells back to their normal state. The results revealed that a chemical, referred to by the lab as "DBPQ," has the ability to destroy polyploid cells, while leaving normal cells unharmed. The lab is actively exploring how this chemical destroys the polyploid cells and how it could be incorporated into a product to treat cancer.

There is more to the human biology than we had anticipated.

Since the discovery of cytofission in human cells, the lab has worked in close relation with the Wisconsin State Laboratory of Hygiene, where the karyotype analysis was done. This analysis determined the number of chromosomes in each cell. The funding that lead to the discovery of cytofission came from both the National Institute of Health and the American Cancer Society. Moving forward, Dr. Burkard will try to extend the lab's funding and continue studying the relationship be tween cytofission and the chemical DBPQ in hopes of uncovering a new approach to treating cancer.

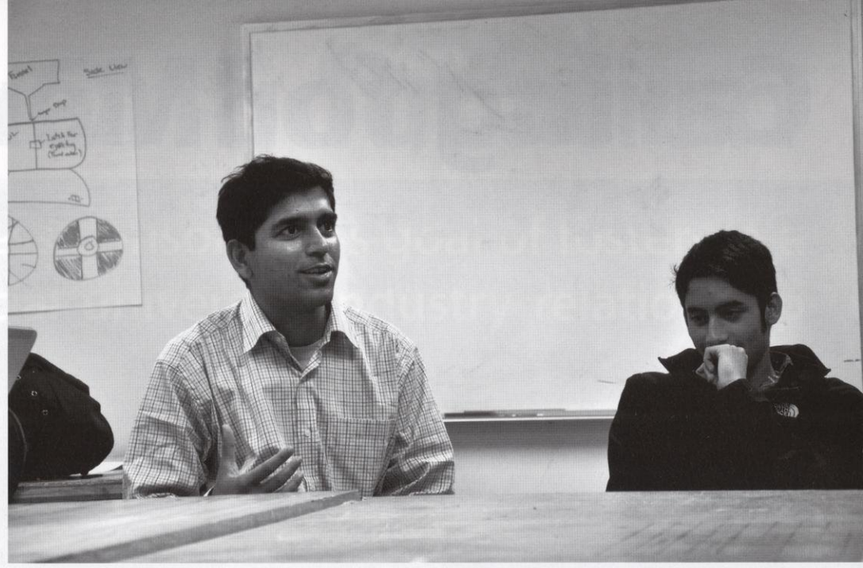
If you're interested in learning more about the progress that the lab has made, Dr. Burkard plans on presenting at the American Association of Cancer Research (AACR) meeting this spring. You will be able to find the press releases related to his presentation on the AACR webpage as the spring meeting approaches. Dr. Burkard also expects to have his most recent findings pertaining to the chemical DBPQ published in an unspecified public journal in the near future. WE



Pictured above is a time lapse of cytofission, captured by Dr. Burkard's photograhic microscope over an eight hour span.

Written by: Justin Alt
Photography by: James Cho
Design by: Grace Liu

Engineering World Health



A small but potent student group on a mission to save lives across the globe

When it comes to strength in numbers, Engineering World Health does not immediately strike one as a force to be reckoned with. Yet, what this student organization lacks in size, it makes up for in motivation, ingenuity, and passion for its cause. The diverse group consists of engineering students from different disciplines and backgrounds, but they share a common purpose: improving global health by implementing simple medical technologies in developing nations.

For these students, the student organization Engineering World Health (EWH) provides opportunities to work on identified health needs, as well as a support system for implementing their own design projects on a global level. "We basically consist of self-starters who are interested in working on a variety of different global health-related projects," explains Dr. Amit Nimunkar, the organization's current faculty advisor. "Each student is working on their own project, but together, our goal is to uphold the Wisconsin Idea – the principle that UW-Madison, or the Wisconsin system, should work to improve people's lives beyond the classroom."

The UW-Madison chapter of EWH is fairly young – it has been conducting weekly meetings in the Engineering Centers Building only since 2006, when the organization was founded by a group of biomedical engineering students. These students included Nimunkar, who was then working on his PhD. Although membership typically hangs around only 10-15 students, the ideas and discussions that develop in the meeting room are immense. "We expose students to global health issues, but we encourage them to think of local solutions, solutions which are relevant to the environment in which those issues occur," says Nimunkar, which, he explains, helps to concentrate the group's efforts, rather than confronting head-on the colossal wall of problems that are categorized as "global health issues." With this perspective in mind, members of EWH focus on health issues specific to individual communities and begin to develop designs for devices and systems that will address those needs.

One of the communities fortunate enough to be receiving aid from EWH is the city of Olanchito, Honduras. In January of 2013, the city's lack of a water fluoridation system was brought to the attention of sophomores Graham Michaels and Emily Carroll. Despite having almost no prior knowledge on the subject, the two dove into the project without hesitation. "The ratio of dentists to citizens in Honduras is ridiculously low," says Carroll. "Especially in rural areas, there is almost no dental care available at all." Installing a water fluoridation system would go a long way toward improving dental health for the 60,000 plus citizens of Olanchito. Although this community is the current focus of the project, the engineering students have their sights set even higher. "It is obviously still in its early stages, but I think our long-term goal is to make it a satellite project that could eventually be mimicked by communities all across Honduras," says Michaels. "The idea is that it will be a self-sustaining system funded by the municipal government once it is implemented."

Most of the work that Carroll and Michaels have completed so far has consisted of research and outreach to onsite contacts, but now the two are itching to travel to their project location in order to evaluate the situation in Olanchito and transition into the design phase. "If we were doing the project here, we would know what the next steps would be. But we need to go to Olanchito to determine what their next steps would be in a different culture," says Carroll. "We are hoping to travel there this coming January." Both students are very excited about their project. "It is a cool way to help people out that is also meaningful on a large scale," says Michaels.

Indeed, EWH members do not seem to have a small-scale mindset. Another design team made up of biomedical engineering students Caleb Durante, Drew Birrenkott, and Brad Wendorff is hard at work developing a design for a medical device which, if all goes as planned, could help to save the lives of thousands. The roots of their project, the Infant Cardio Respiratory (CaRe) Monitor, can be traced back to 2011, when Durante and Birrenkott chose to create a device to address an EWH prompt for their BME design program.

"The prompt was to build a respiratory/apnea monitor for use in the developing world because of the high incidence of sudden infant death syndrome and apnea (abrupt cessation of breathing) related deaths," recalls Durante. "This was a response to one of the United Nations' Millennium Development Goals to reduce the under-five child mortality rate by two thirds between 1990 and 2015." In 2011, the world's under-five mortality rate was 87 deaths per 1000 births, and the neonatal mortality rate was 32 deaths per 1000 births. In many developing nations, these numbers were over twice as high. Of these deaths, 22 percent were attributed to asphyxia (severe deficiency of oxygen in the body) and 26 percent to preterm birth complications such as underdevelopment of the heart and lungs. "We believe that this 48 percent would be easily preventable with the CaRe Monitor," says Durante.

Judging by appearance alone, it is hard to believe that the Infant CaRe Monitor could achieve such a lofty goal. Though it consists of nothing more than an elastic band with rubber electrodes and the small rectangular monitoring device itself, the simple exterior of the CaRe Monitor belies its inner complexity. When in use, the band wraps around the infant's chest and passes a high-frequency electric signal through the torso, which returns to the monitor overlaid with the wave functions of the body's breathing cycle and heart rhythm. "What we have programmed it to do is to compare that to the previous twenty to thirty seconds of data, and if it changes, we know we have an issue," explains Birrenkott. "If the infant's breathing flatlines for more than 18.5 seconds, an alarm goes off, and if the heartbeat does the same thing, the same alarm goes off. Then the caretaker knows to check up on the child."

The team's ultimate goal is to have their device mass-produced for use in developing nations. This summer, Nimunkar took the prototype overseas to discuss the design with potential client GR Medi Corp, a medical technology manufacturer in India. "The client made some suggestions towards making it more manufacturable but is interested in actually receiving the designs for this project and producing them," says Durante. He and his design team will spend this semester making these adjustments and refining their design. "After those iterations, it is going to be hardcore testing for technical validation. There are a lot of electrical safety guidelines that we have to abide by, and the whole idea of live subject testing is still up in the air," comments Wendorff. If the client accepts their final design, the three students are hopeful that their success in India could propel their product even further afield to markets in many other countries.

The effects of EWH's work are resonating around the world, but its members are making a difference closer to home as well. In the fall of 2012, EWH began collaborating with the Wisconsin Medical Project (WMP), a nonprofit organization here in Madison. "It's a big warehouse maintained by retired doctors who acquire medical equipment from donating hospitals and send it off to many places, for example Cuba," says EWH vice president Joshua Zent. Members go to the warehouse once or twice a week to try their hand at fixing any of the donated equipment that is broken or out-of-date. Everyone involved gains something from the experience, explains Zent. "Not only are we there trying to help, but we are also learning. You do not get to go play around with medical equipment just anywhere."

This sort of work has been a major part of EWH's operations for many years now and has also been the basis for some of the group's past travel experiences. In 2011, Zent and three other students accompanied Nimunkar to Belize to perform equipment repairs in area clinics. Prior to that, in 2009 Nimunkar travelled to Mongolia to do similar work. Both found shocking conditions: clinics that did not have the expertise do something as simple as a few stitches and hospitals that would spontaneously lose power in the middle of an open heart surgery. For EWH, awareness of such low health standards is at once disheartening and motivating as their small group strives to make a difference against such a formidable foe.

"You have done something, and you can see the effects, but then you suddenly realize that there is so much left to be done," says Nimunkar. "We have endless energy because there is an endless source of problems, and that's the motivation for our organization; that's the motivation for us as engineers to do what we were trained for." WE

Written by: Alyssa Hantzch
Photography by: Catie Qi
Design by: Cara Sandlass

Caring for Mendota:
The Bioretention Project

Efforts to cut down Lake Mendota's algae population are underway.

Lake Mendota is one of the best features on campus. However, most have noticed a unique aroma rolling off the shores of this timeless piece of UW-Madison. What is causing this distinguishing characteristic of our lake?

The water pipe system pumping into Lake Mendota stationed along Lakeshore path

The answer is phosphorous, an element that washes into Lake Mendota via sediment present in stormwater runoff. Once the phosphorous reaches the lake, it acts as a fertilizer that fosters algae blooms. These blooms account for the unpleasant smell associated with lake water.

The solution to this problem sounds easy: rid the stormwater runoff of phosphorous! Unfortunately, this is no simple task. Phosphorous is incredibly difficult to remove from the water and sediment that washes into the lake.

This is where the experts come in: UW-Madison alumna Rhonda James, a landscape architect, and Matt Collins, a civil engineer, are project managers of a UW-Madison stormwater management project including ponds and bioretention that aims to reduce the amount of sediment present in runoff before it reaches the lake.

Bioretention is a process in which sediment is removed from stormwater runoff. This is achieved through installation of a bioretention basin: a sort of "rain garden" containing multiple layers of soil specifically meant to filter runoff that collects in the basin. A bioretention basin is also topped off with deep-rooted plants to increase water absorption. Currently, James and Collins's project includes four completed bioretention basins in Eagle Heights, as well as the reconstruction of a drainage ditch to become a series of bioretention basins along University Bay Drive and two stormwater ponds near Lot 60 and Triangle Marsh.

The bioretention project did not start up overnight. It formally began around seven years ago after several studies indicated that phosphorus levels in the lake were too high, and, consequently, stormwater quality needed improving. Not only did research suggest something needed to change, but the Department of Natural Resources also required action. The UW-Madison campus goal of 40 percent sediment removal will lessen the amount of phosphorous reaching the lake.

To achieve the 40 percent sediment removal standard and lower the amount of dissolved phosphorous in Lake Mendota, many departments on campus collaborated. James found this to be a very positive part of the design process that began in 2010: "I think it's a pretty holistic way of looking at [a project] when you have the various disciplines working together. As a landscape architect working with a civil engineer, I think we cover a lot of bases."

From engineers to ecologists, many perspectives were involved in the two-phase project. Phase one included the construction of bioretention basins in Eagle Heights, a family housing area where it was important to minimize long-standing water. Four basins were constructed to collect the stormwater that penetrates into the ground as it moves through a system of engineered soil that was specifically designed to filter sediment out. This engineered soil is about three feet thick and consists of mostly sand with iron filings to bond with phosphorous for effective removal and a small amount of compost in the top few inches. On the surface of the basin, plant species native to the area with deep roots were planted to absorb additional stormwater and ultimately filter suspended solids from runoff, in addition to reducing the peak flow off the land. All of this was completed in 2012 and has so far been successful. According to James, "We know, especially from the last few rains, that [the Eagle Heights basins] are holding water and draining it down."

> **"I think it is a pretty holistic way of looking at [a project] when you have the various disciplines working together..."**
>
> **- Rhonda James**

Phase two of the bioretention project is happening now. Construction began earlier this year on the University Bay Drive ditches and two wet detention ponds: Lot 60 pond and Triangle Marsh pond. The University Bay Drive ditches will use bioretention like the basins in Eagle Heights; however, a different engineered soil called "sorbtive media" will be utilized. This brings up the potential for research, something James considers a unique highlight of the bioretention project. The retention basins in Eagle Heights can be compared with the University Bay Drive ditches to determine which engineered soil traps phosphorus more effectively. As for the detention ponds, Lot 60 and Triangle Marsh, there is less to learn. These do exactly what their name suggests: detain water long enough for sediment to settle to the bottom of the pond.

The entire project is scheduled to wrap up by the end of 2014. As for the often unappealing aroma of Lake Mendota, "It's hard to predict when that will disappear," James says. Besides, the main goal is to keep our lovely Lake Mendota healthy, smell or no smell! WE

Written by: Margaret Donnell
Photography by: Abby Schaefer
Design by: Lukas Lindquist

Hands-On Education

The UW E-Business Consortium's goal of fostering a mutually beneficial university-industry relationship

Left: Dr. Raj Veeramani, Executive Director of the UWEBC, hosts the 2013 Conference at the Monona Terrace, Right: Daniel Burrus presents as the closing keynote speaker

Over a century ago, former UW-Madison President Charles R. Van Hise articulated what is known as the Wisconsin Idea, which states that the boundaries of the university are the boundaries of the state. This now famous philosophy focuses on the principle that UW-Madison should improve people's lives beyond the classroom by extending the beneficent influence of the university to every family in the state and world. The Wisconsin Idea continues to serve as a driving force behind every program, department, and partnership fostered by UW-Madison. The idea of using the educational resources of UW-Madison to make an impact on businesses, the economy and the quality of life of people throughout the world remains ingrained in the faculty, students and alumni of UW-Madison.

One such example of this dedication is the UW E-Business Consortium (UWEBC). Spurred by the Wisconsin Idea's goal of leaving a lasting impact on the broader society, Dr. Raj Veeramani, Executive Director of the UWEBC, invited a group of senior executives to the UW-Madison campus with the goal of answering the question, "How can UW-Madison best help industry succeed with e-commerce?" Executives called for a trusted, noncommercial and collaborative environment for companies to learn and share experiences regarding emerging web technologies, next generation ideas and best practices.

With that, the UWEBC was founded. "As a university, we are unique in that we are able to provide companies with unbiased information regarding their companies and business practices," Veeramani says. He continued, "The UWEBC is an industry-university partnership that in many ways represents a community centered around collaborative learning in a noncommercial setting."

Founded in 1998, the UWEBC offers many benefits to its member companies through a wide range of initiatives. In order to facilitate a peer-to-peer learning community, the UWEBC encourages executives, managers and senior practitioners of it's member companies to learn from one another. An annual company membership fee grants all company employees access to more than 50 professionally facilitated learning events. These events feature topic-centered peer groups, special interest groups and executive retreats, all of which provide member companies with specific meetings geared towards addressing important ideas and areas within businesses. Other types of benefits include member-to-member advising and company-specific projects, both of which aid companies in dealing with issues and problems unique to their company.

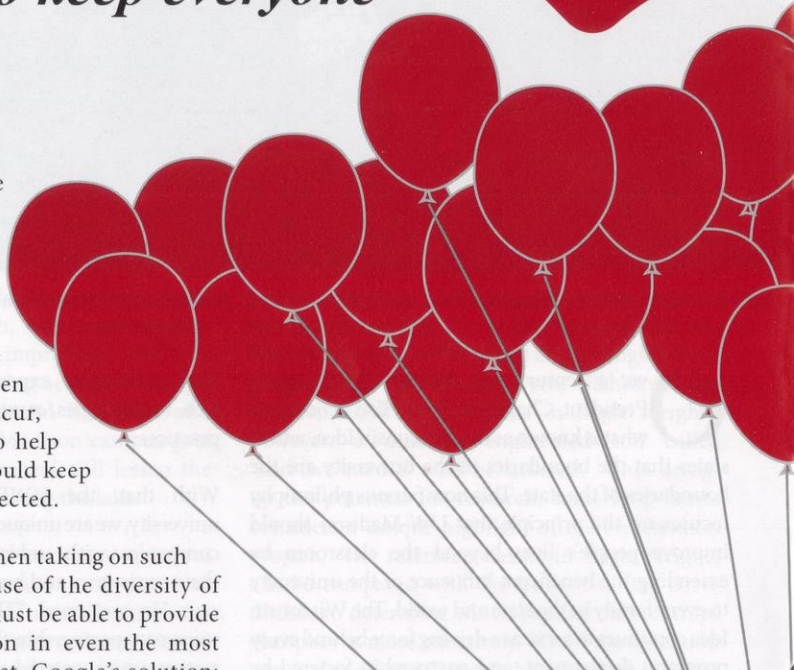
An annual conference held each year in Madison serves as a celebration of the new relationships and partnerships formed through the professionally facilitated learning events. The conferences bring together and inspire all member companies with regards to new and innovative business practices across all industries. The 2013 conference focused on marketing, IT and supply chain management. A variety world-renowned experts gathered to share their experiences and strategies for success, including Daniel Burrus, a leading futurist on global trends and innovation who is also the founder and CEO of Burrus Research. WE

Article continues online at www.wisconsinengineer.com

Written by: Matt Latuszek
Photography by: Grace Liu
Design by: Grace Liu

An Idea that's Not Just Full of Hot Air

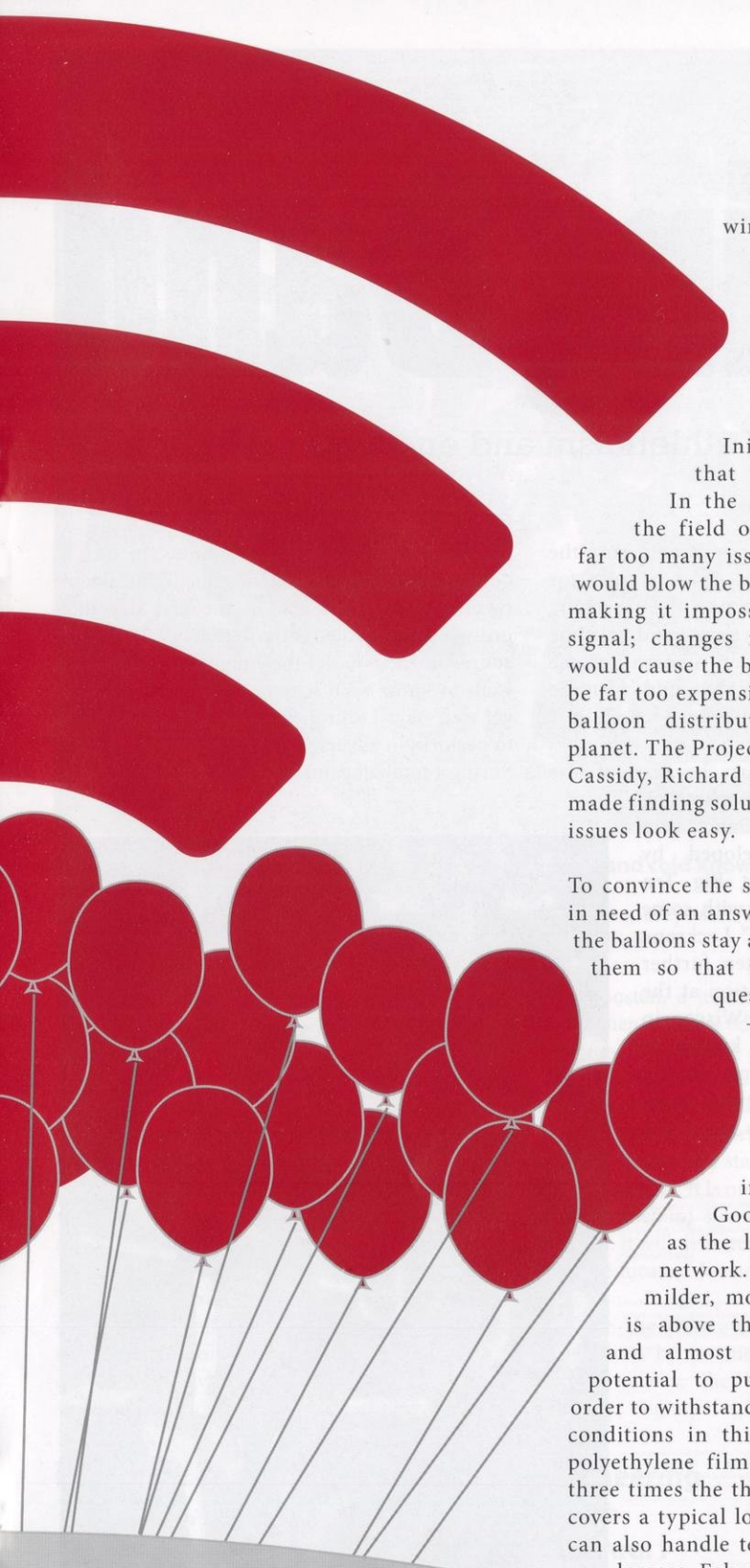
How Google is using balloons to keep everyone connected online



Just the other day in the midst of doing homework, I decided to take a typical study break and check my email, Facebook, r/science and Yahoo news to see what was going on in the world. Rats! That annoying yellow triangle with the exclamation mark was back again, impeding my study break and denying my internet access. I smirked back at the yellow triangle, pulled out my smart phone and resorted to quickly checking the essential apps before returning to work. While the yellow triangle kept me off the internet for thirty seconds, in the less fortunate corners of the world, some people have not had internet access during their entire lives. About five billion people (two out of every three people in the world) do not have direct access to the internet. Soon, this could be a nonissue. Developed by Google, Project Loon may be the solution to get these people online.

Although it sounds like an impossible feat, Google has taken on the challenge to provide internet access to the entire world. With technology and opportunity developing so quickly, Internet connection for everyone should be a must. Knowledge should not be restricted to solely the rich or those living in heavily populated areas. In the age of technology, when information is available limitless at the touch of a button, everybody deserves a chance to learn. Kids in third-world countries could have a chance to get a college education, and when natural disasters occur, doctors could be able to help from afar. In short, it would keep people everywhere connected.

Where does one begin when taking on such a steep challenge? Because of the diversity of the world, the solution must be able to provide an affordable connection in even the most remote areas of the planet. Google's solution: balloons. Ground stations would provide internet wirelessly to some of the balloons and then the signal would spread from balloon to balloon, creating a whole network in the sky. Each balloon would act as its own



wireless station for an area about 25 miles in diameter below it. Anyone with a Google-issued antenna would then be able to connect to the internet.

Initially, critics thought that this idea was absurd. In the opinions of scientists in the field of ballooning, there were far too many issues with the idea: winds would blow the balloons all over the place, making it impossible to provide a steady signal; changes in altitude and weather would cause the balloons to burst; it would be far too expensive to create a continuous balloon distribution around the entire planet. The Project Loon team, led by Mike Cassidy, Richard DeVaul, and Astro Teller, made finding solutions to these challenging issues look easy.

To convince the skeptics, the first question in need of an answer was how to ensure that the balloons stay afloat and how to fabricate them so that they do not burst. This question raises several others – the kind of material that should be used, where in the air these balloons will float and how to avoid detrimental collisions with objects currently in the atmosphere. First, Google chose the stratosphere as the location for their balloon network. The stratosphere has milder, more predictable winds and is above the weather, birds, planes and almost anything that has the potential to puncture the balloons. In order to withstand the extreme low-pressure conditions in this environment, a special polyethylene film was chosen that is only three times the thickness of the plastic that covers a typical loaf of bread. This material can also handle temperatures as low as -58 degrees Fahrenheit. The Project Loon team believes the balloons will be able to last at least 100 days in flight before deflating and parachuting back down to earth. The 100-day flight period allows for a full ring of balloons to stay consistently afloat to provide internet access everywhere. The nearest any recent balloon has come to a long-duration flight was 55 days, and that was by a much larger NASA balloon, but Google claims with certainty that their balloon will stay afloat for much longer.

The next questions to ask include: how will the balloons keep a constant connection? How will they stay in a proper alignment to maintain connection with each other, and how will they maintain power? Google's answer to the first question comes in the form of a question – why do the balloons need to stay in the same spot? As previously mentioned, there will be a continuous distribution of balloons surrounding the planet. If one balloon moves out of reach for a given area, as long as another balloon floats to the spot, the connection should never be lost. The technology allows the balloons to know the positions of all of the other balloons so that Google will know what areas of the world are in need. Google would then be able to control the balloon's position slightly by adjusting vertical position, which allows the balloon to strategically catch a stratospheric wind current and move to a desired location. To maintain power and keep connectivity, there would be a five-foot by five-foot solar panel generating 100 watts per day – enough to power the unit and charge batteries to keep the balloon running all night.

Despite the idea sounding a bit loony, Google is confident that these internet-supplying balloons will work. The project was named "Project Loon" for a reason. Many critics have shot down the idea, but Google is definitely taking a bold step in the right direction. Technology can promote learning for all, but without an Internet connection, so many opportunities are lost. Whether Project Loon will grant this access to everyone soon is still a question, but the future does look bright. Technology will keep developing, and now we can see that the sky actually is not the limit anymore. WE

Written by: Charlie Duff

Design by: Ryan Krull

UW-Madison Marching Band

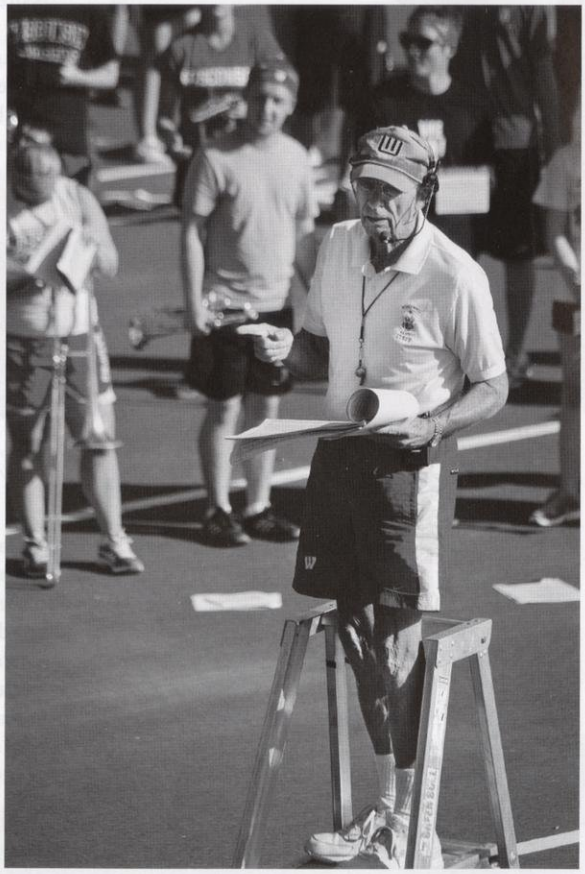
The Wisconsin Band is a unique blend of athleticism and engineering.

The University of Wisconsin Marching Band has been around since 1885, and many things have changed in those 128 years. Not only has the marching style become one of the most unique in the band community, but the function and makeup of the band has changed drastically as well. Whereas all sheet music used to be handwritten, students now work with Director Michael Leckrone to computerize the music. In addition, the band once was primarily populated by music majors. Now, all schools within the university are well represented, particularly the College of Engineering. The distinctive combination of intense physical fitness and modern technology and engineering is what makes the band so enjoyable and successful.

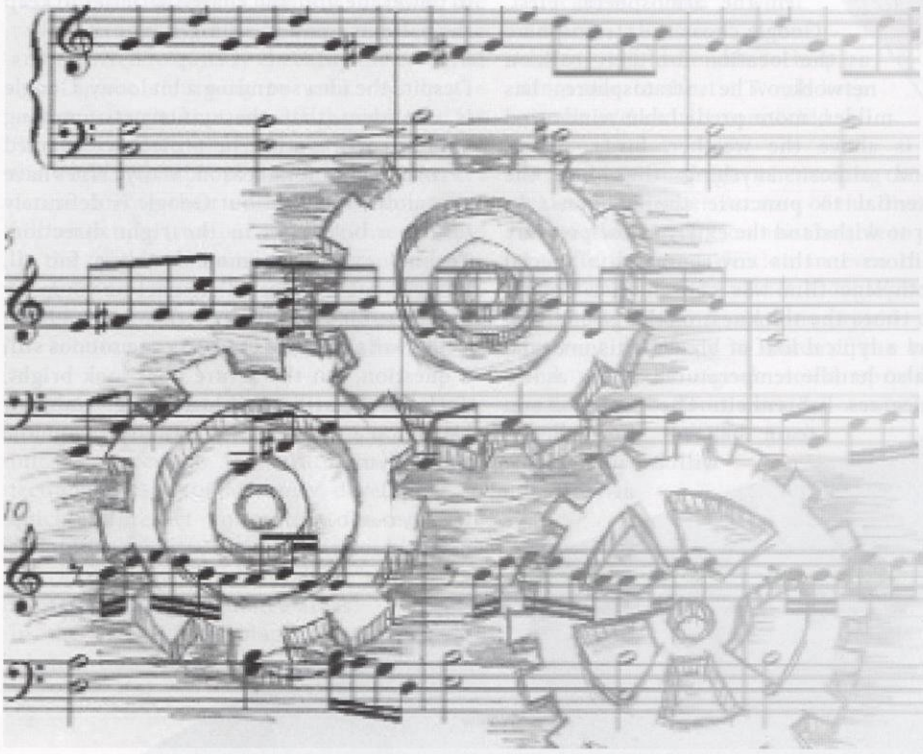
Returning university band members undergo an average of nine days of intense physical conditioning in late August to prepare for an upcoming season. In the week prior to the opening football game, both returning and prospective members report to the practice field two to three times per day for conditioning drills, perfecting the marching form and practicing the pregame and halftime shows. Several band members report a "reverse freshman 15," as they lose 15 pounds or more as a result of the grueling workout schedule.

Conditioning is necessary because of the intense physicality of the marching style. The Wisconsin Band uses a marching step developed by Leckrone. Whereas most Big Ten marching bands perform with some variant of the "high step," Leckrone took that method one step further and added a slight hesitation at the top of the stride. Thus, the Wisconsin Band marching style is known as "stop at the top." Holding the leg and thigh up at a 45-degree angle is what makes the step so physically demanding.

The band is known for its toughness, to such a degree that cancelling practice due to inclement weather is unheard of. On the first day that prospective freshmen come to practice, Leckrone addresses the issue of inclement weather: "You want to know what happens when it rains? We get wet," says Leckrone. The band must be able to perform in adverse conditions; if there is rain during a football game, the show must go on.



Leckrone hand writes all of the music the marching band performs



Marching band members will practice in the rain, heat and cold knowing that the show must go on

But the marching is only half of what goes onto the field; the music also undergoes a unique journey to Camp Randall. Professor Leckrone personally arranges all of the music played by the band. While most band directors use computer programs, Leckrone opts to write out his arrangements by hand, using pencil and paper. He writes the music for every instrument on what is known as a score, which is the collection of all parts for a particular song. Leckrone then gives the handwritten score to the copy staff, whose job is to enter every part into the sheet music program, Finale.

The copying process has several steps. First, the copyists enter all of the notes into Finale using an electric piano. Next, they have to add the articulations, which are directions of playing style. Some articulations make notes longer, some shorter and some louder. Accurate articulations are vital because the overall playing style is directly derived from the articulations. After the articulations, the copyists proofread their work to ensure all the notes are correct. Finally, the copyists format the individual parts that each band member will play. Once the copyists receive the score, they often have less than 48 hours to finish their job.

Dan Joosten, a junior trombone player and an instrumental music education major, is one of the copyists. "My favorite part is being part of the big picture in band … you are the one that puts them into Finale, you are the one that makes the band able to play it," Joosten says. He has a particular interest in the copy staff because of his future as a music teacher. "It is nice to see how Mike arranges and what chord structures and instrumentation he uses. It will definitely help me in my career as a music educator," Joosten says.

Despite the inherently musical nature of the band, it is by no means comprised of mostly music majors; the most prevalent major is actually engineering. Lauren Saleh, a junior trumpet player in biological systems engineering, thinks that the both engineering and band are not only doable, but the combination of the two is somewhat symbiotic. "Like with any other form of exercise, I find that band serves as a stress reliever more than anything. I think of it less as a time crunch and more as an escape from classes," Saleh says. The time commitments required to succeed in both band and engineering classes teaches those students to be especially self-disciplined regarding work time. "Having entire Saturdays or weekends booked up forces me to manage my study time much more wisely," Saleh adds.

"When 40 percent of the band is engineering majors, it is likely that at least a couple band members will be in a class with you. I absolutely feel like there is a support system in band between engineers."

-Lauren Saleh

In addition to the concrete benefits, there are other benefits to being an engineering student in the marching band, such as the large number of other engineering students. Saleh says, "When 40 percent of the band is engineering majors, it is likely that at least a couple band members will be in a class with you. It is comforting to walk into a new class and immediately see friends you can study with. I absolutely feel like there is a support system in band between engineers. It is always nice to head up to 4th floor Wendt and see at least a few familiar faces."

The presence of engineers has made a marked improvement in the function of the band; many skills learned in engineering classes, especially group projects and problem solving, are often utilized in daily band function. This is most evident in troubleshooting technological issues, quickly moving people and equipment, and improving the efficiency of functions like sign-up processes. The engineering work ethic also comes in handy when rehearsals become long and arduous. The Wisconsin Band strives to take full advantage of its members' diverse skill sets, and the engineering students are a vital component of the continual i mprovement of the band. WE

Written by: Andy Kerber

Photography by: Christian Fabian

Design by: Tanae Swenson

Engineering in the Food Industry

Engineering is found all around us in the forms of technology and skyscrapers, but what about in the food industry?

As students walk around campus, they are surrounded by engineering marvels. From the majestic Engineering Centers Building to the smart cars and hybrid vehicles that whiz throughout campus, engineers have left their mark. However, one area not commonly thought to be related to engineering is food service. Digging deeper into the work involved in building, preparing and running the residential dining halls on campus, it is easy to find feats of engineering, specifically industrial engineering.

Lean manufacturing, Kaizen continuous improvement and Six Sigma are just a few phrases industrial engineers use to describe projects that involve reducing waste and improving quality. These projects usually focus on manufacturing plants or hospitals, but what about in the dining halls on campus? Starting this year, UW-Madison Dining and Culinary Services has teamed up with Six Sigma Blackbelt Scott Converse to help reduce waste across all halls on campus. This mission began in August 2013, as each dining hall was required to generate one Lean Six (combination of lean manufacturing and Six Sigma) project to pursue throughout the semester. Converse explains that the waste involved in institutions is the most common causes of inefficiencies. From that point, each hall brainstormed, and many thought of ways to reduce food waste, while others examined wasted time and inefficiencies.

Newell's Deli, a dining hall located in Smith Hall, decided to reduce waste through implementing lean manufacturing tools. After thorough discussion, Newell's staff decided to reduce waste by making less food and keeping accurate production records. The plan consists of making fewer burgers at a time and using a made-to-order approach, instead of so many at once; this is considerably different than the process used in previous years. Before, it was believed that making five or six burgers at a

At the beginning of lunch and dinner, only a few hamburgers are put on the grill at Newell's Deli

time when supply was low was more efficient so that there would always be burgers available for customers when they arrived. Now, only one or two additional burgers are made. This has led to a drastic reduction in waste, and in some instances, no food waste at all.

As a result of producing fewer burgers, it would be expected that at some point, Newell's would fall behind the demand and customers would be forced to wait, which was avoided with the previous approach. While this did prove true, it was not as large a problem as expected; the average wait time for a burger is three minutes. This leaves the customer with time to peruse the rest of the store, potentially increasing sales, and, as an added benefit, he or she can watch the burger cook. The customer will know for certain that the burger is fresh because they can physically see it. "I was a little irritated at first, but the fact you can see the burger being made, then you know it's fresh, versus the mystery when it's sitting on the line," says regular Joey Laabs. Not only does Newell's reduce waste, but its customers are also happier; Newell's is ahead $2,000 more in profit compared to last year, while serving the same amount of customers. Crunching the numbers, they are throwing out less food (less money lost) and serving more food (more money gained). This leaves Newell's with a surplus to purchase more obscure items for the store that they normally would not be able to, including themed events and parties for residents.

"I was a little irritated at first, but the fact that you can see the burger being made then you know it's fresh versus the mystery when it's sitting on the line"

- Joey Laabs

Another engineering practice implemented is forecasting, especially with food items other than burgers. In previous years, production records were kept, but only occasionally; what was made or leftover was not recorded. Because of this, Newell's could not forecast accurately and could not predict future meals. Now, everything is recorded and cross-checked through their Point-of-Sale cashiering system, so they know exactly how much was produced and served. Through this system, they will have a better understanding of what sells and how much to cook, further reducing waste.

Most people do not know or even notice how influential engineering has been in the food service industry. For example, McDonalds has become a leading fast food chain through their implementation of industrial engineering tools. The dining halls on campus are now using some of these tools, and so far it has been extremely effective. WE

Written by: Christopher Ross

Photography by: Christopher Ross

Design by: Margaret Butzen

A Little Competition Is a Good Thing, or Is It?

An insight into the recent increase in enrollment within the College of Engineering and its affect on those involved in the college.

"A little competition is a good thing." It is a classic phrase, and holds true in many aspects of life. However, when it comes to acceptance into a desired major, is competition really a good thing? Over the last few years, the UW-Madison College of Engineering has witnessed an increase in enrollment. This is causing more and more departments to reach capacity, which in turn leads to stricter acceptance requirements. These changes are initiating many different changes throughout the college as a whole.

"Over the last three years, our enrollment has been steadily increasing every year," says Beth Dawson, Senior Advisor and Director of the EGR Office. The main source of this increase has come through the increase in freshmen, which affects the whole college down the line. The effects are felt in the individual departments a year or two down the road. Those freshmen go to apply to their respective departments, and more and more of the departments are reaching capacity. "We are seeing more of our departments filling, and students not necessarily getting into their department of first choice. Approximately 85% of our students are getting into their department first choice," Dawson says. However, this statistic could be misleading as it involves all engineering majors, including some that have always been very competitive.

These newly competitive majors, now including almost half of those within the college, joined others such as biomedical and chemical engineering in mandatory Department Admissions Meetings. At these meetings, the committee reviews the student record based on the minimum requirements, the course loads and course combinations, grade trends, etc. Because departments cannot admit every student who applies, these meetings implement an overall slightly stricter set of requirements that can help them decide who they wish to accept.

So what are these new requirements that some of the departments have had to adopt? "Every department has the same entrance requirements. For a department not at capacity, if you are a student who meets the General College Requirements (GCR), you will get in to that department," Dawson says. However, if a student is applying to one of the now stricter engineering departments and they barely meet the minimum GCR, then that student's chance of gaining admittance is not ensured.

Students have four semesters to qualify for their department, and a student in his or her fourth semester will then have limited options. "We tell them that if they meet the GCR, they still might not be admissible to their first choice. We then present them with the departments that are currently open and ask if they would like to be admitted to one of them," Dawson says. Fourth semester students can also appeal to a department. If a particular student feels that he or she had one semester with extenuating circumstances, they can appeal their admissions decision. "There are three things that could happen from that," Dawson adds. "The obvious yes, we will admit you. The second would be: No, we will not admit you. The third is that the department might say, they will allow the student one more semester to qualify and list some stipulations."

It remains unclear if some of the majors will be expanding in the near future to accommodate more students as a result of many departments hitting their ceiling enrollments. It is in the process of being discussed, but there are problems with this. "There are some departments that are not going to be able to increase their admissions capacity because of factors such as lab space, for example," Dawson says. These are among the things that the deans of the College of Engineering are considering. "Mechanical Engineering and Biomedical Engineering in particular are under very high demand," says Steve Cramer, Associate Dean of Academic Affairs-College of Engineering. "We are seeking to expand available seats in these two departments and others but are constrained by budget."

"I think it is making students think more about what they want to do."

- Beth Dawson

With the overall enrollment in the College of Engineering increasing rapidly, it is worth noting that the class sizes are being handled in different ways based on the class. "Generally no, teaching loads have not gone up," says Cramer. "Are they teacher larger classes? Yes." Professors are handling this by using technology to manage their increased workload. Not all classes have the luxury to be increased. Things like lab space and lecture sizes are being considered, but it does ultimately depend on the department and the course. The good news is that according to Dawson, "We have been able to get all of our students a full load of courses." This is critical to making sure that all students stay on the right track towards graduation.

The increase in students does actually have some positive effects within the College of Engineering as well. "I think it is making students think more about what they want to do. We are trying to help them think about other alternative paths," Dawson says. This way, students can make sure that they are doing exactly what they want and that they are heading down the right path in order to achieve a desired future.

Also, this does have an effect on the community as a whole as well. "An engineering degree with the preparation it provides is one of the surest paths to employment of all available degrees," says Cramer. "Engineering degrees consistently appear in lists of professions that pay the most. Furthermore, engineers help drive our economy and many times the innovation they provide leads to new companies and new products, which in turn provides new commerce and new job opportunities for others. The Wisconsin and the United States needs more engineers for its economy."

"Seven or eight years ago we did not have to face the possibility of students not getting in to their first choice, but we do now," Dawson says. Although these new difficulties have arisen, the College of Engineering and the students themselves still thrive and are getting a well-respected engineering degree that is rigorously preparing them for the world to follow. WE

Written by: Zach White

Photography by: Sommer Ahmad

Design by: James DeBano

***Above*: One way that the College of Engineering is accommodating the increase in engineering enrollment is by having engineering professors teach larger lectures which opens up more seats for each class**

***Top Left Photo*: The sharp increase in engineering enrollment is evident in the crowds of students on the engineering campus**

NASA 3-D Collapsible Printer

The Call

NASA has issued a challenge to university students across America, and here at UW-Madison, a team has formed to answer. While 3D printing technology has come far on Earth, NASA is looking further into the uncharted territory of building one that can operate in space. This introduces difficulties previously unseen, as not only does it have to function precisely in a micro-gravity environment, but it also needs to work at a fraction of its original size.

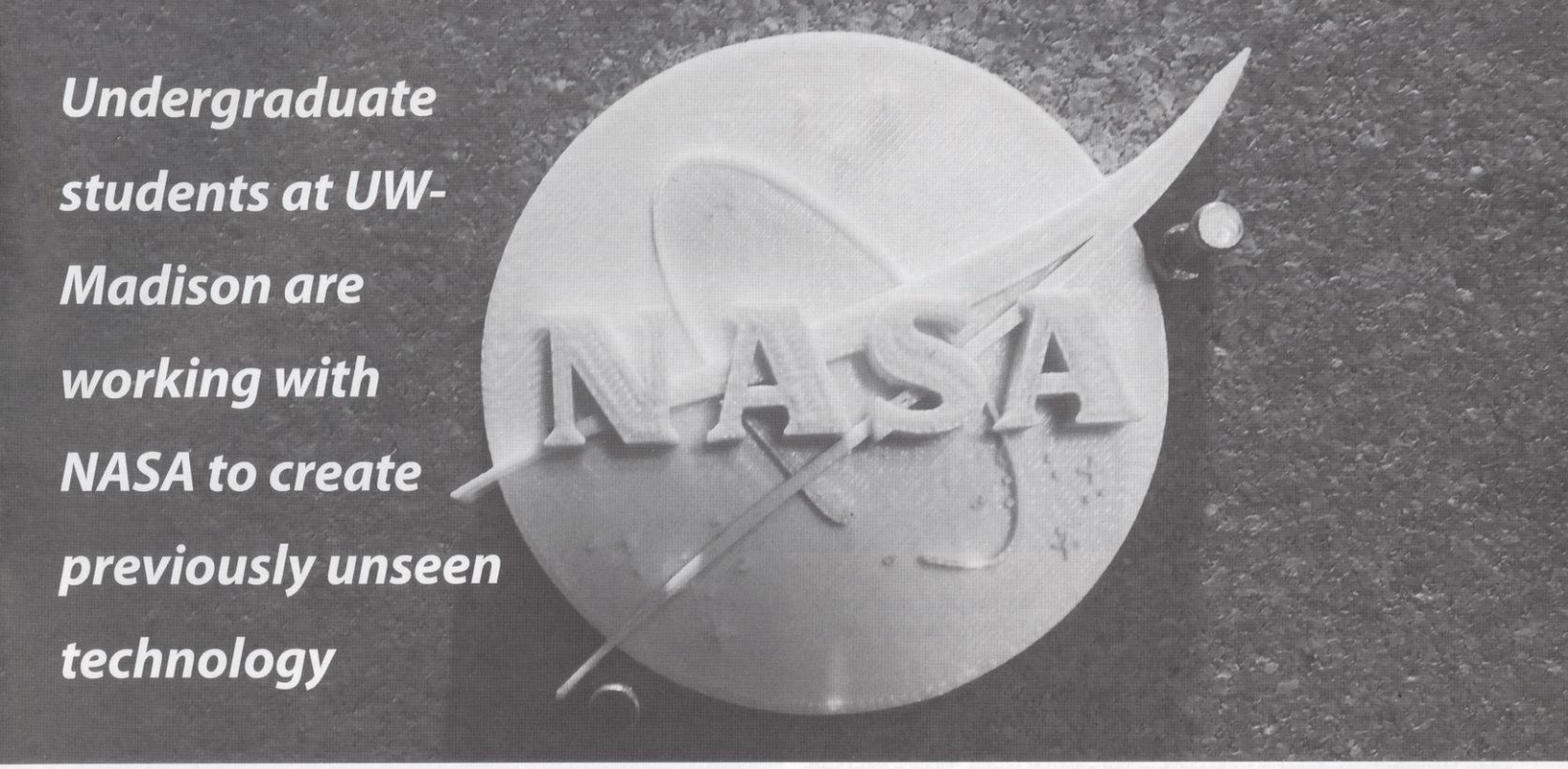
The reasoning for 3D printing in space is relatively straightforward. Here on Earth, when a tool is lost it only takes an extra 10 minutes to run over to the local hardware store and find a replacement. However, in space, finding replacements becomes a little more complicated. With only so much room available on space launch vehicles and space habitats, the ability to print out broken tools and small parts not only reduces the amount of weight and volume aboard a launch (thereby dramatically reducing the cost), but also allows a crew to perform research and function longer on the International Space Station without having to resupply.

The Team

When you imagine a group of engineers working to design a state-of-the-art 3D printer, you probably do not picture a group of undergraduate students with majors ranging from mechanical engineering to environmental sciences. However, this is the team (called Badger COMET) that has taken the challenge here at UW-Madison.

Their journey began in March of 2013 when Dr. Frederick Elder, a design professor at UW-Madison, approached some of his senior students to see if they would be interested in forming a group for the project. COMET quickly began growing, and, after months of research, the team submitted a proposal to NASA and was selected to continue. Designing the project from the ground up requires a range of expertise, from computer programming and circuit board design to the mechanical design of how the printer will collapse and operate in micro-gravity. Ryan Knippel, the sole graduate student working on the project, commenting on the diversity of the people involved, says, "It is an experience that we don't get otherwise, working in our department. [COMET] is more like working in the field, where you need everyone to come together and meet in the middle to finish the project."

As the team continues with its research and development, the University of Wisconsin-Madison has stepped up and offered its full resources. With a substantial amount in funding coming from various engineering departments, COMET now has the full ability to design and create a working prototype.



Undergraduate students at UW-Madison are working with NASA to create previously unseen technology

The Challenge

While 3D printing technology has come far here on earth, creating a tool that functions accurately in space while having the ability to collapse on itself to save on volume is unexplored technology. The main issues faced are threefold. First, all of the components that rely on gravity must be modified so they will perform with the same precision in micro-gravity. Second, because there will be no dedicated taskforce working solely on the 3D printer in space, it needs to have the ability to correct common errors autonomously, such as re-calibrating sensors that allow consistent printing on the x-y-z planes. Finally, the ability to collapse on itself means that not all of the components of the printer can be rigid, especially the printing axis and table. COMET has been researching alternative materials for a printing table, such as fabric, which would not only allow the printing table to collapse, but also provide a taut surface that a part could be printed on and taken off easily.

While the team is still doing research, they have come up with a design that would meet all of the requirements that NASA has put forth. It allows the printing table to fold twice, thereby saving the most space. However, mechanically it is difficult to control and move. Moving forward, their goal is to improve the process through further design and prototyping.

Designing the project from the ground up requires a range of expertise from computer programming and circuit board design to the mechanical design of how the printer will collapse and operate in micro-gravity.

The Future

While the entire process will take over a year to complete, the Badger COMET team is nothing but determined and excited for what lies ahead. I ended the interview by asking the members to state the aspect of the project that excited them the most. Many talked about the jobs in aerospace that they hoped to get after receiving their diploma; others discussed how it was a privilege to work on cutting-edge technology. However, I think that Alex Shwartz, an undergraduate majoring in Engineering Mechanics and Astronautics (EMA), said it best. "When you look at the highest expansion of engineering, aeronautics is huge. We are talking about stuff that has never been done before, but here [at UW Madison] we do it every semester in our senior design classes and in our clubs. It is a reflection on our university and our engineering program that they give us the skills to be able to do this kind of work." For the Badger COMET team, watching UW-Madison's EMA program appear in the national spotlight signifies a job well done. WE

Written by: Paul Theis

Photography by: Catherine Finedore

Design by: Nikhil Deshpande

Transcend Engineering

A new student organization goes beyond the conventional framework for making student ideas reality

If one had $5,000 to donate to the College of Engineering, how should the college spend it to make the greatest difference to engineering students, and why?

A year ago, senior mechanical engineering student Max Bock-Aaronson faced this question as he contemplated the College of Engineering's Connect for Life essay. His mind wandered as he brainstormed possible topics. Then, a light bulb came on. Throughout his four years at UW-Madison, Bock-Aaronson had numerous ideas he wanted to develop and to enter in design competitions, but he needed a team.

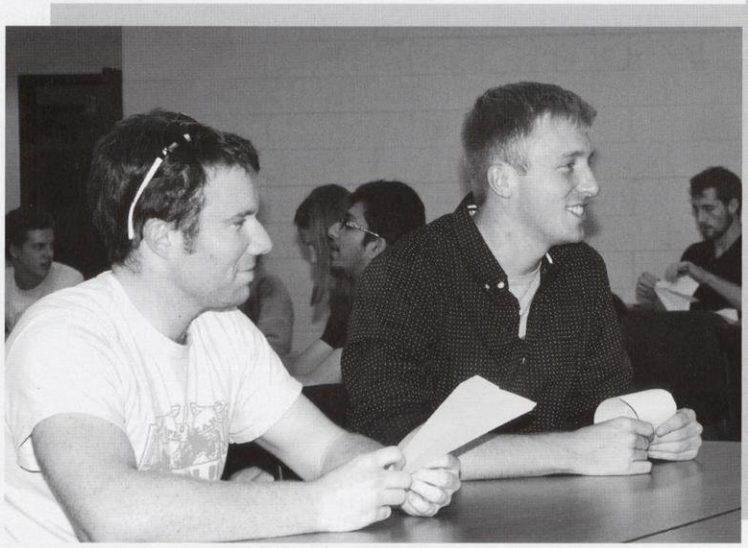
"The assumption that project competitions make is that you already have a brilliant idea and that you're already connected with other students who believe in the same idea. But where do those students meet?" Bock-Aaronson asked.

Bock-Aaronson realized that developing a student think-tank would provide a platform for students to meet and to build on ideas. His essay beat over 90 entries to the competition, and the student think tank, now known as Transcend, was born.

Though only in its second semester, students from the School of Business, the computer science department, and the College of Engineering have each brought fresh perspectives to the beginning stages of development. The first brainstorming session exemplifies the benefit of collaboration. Business students have ideas with complete marketing plans but want input from engineers on design and product development. After the brainstorming stage, group members vote about what they would like to get out of Transcend: do they have an idea, do they want to collaborate on someone else's idea or do they want to enter competitions? From this poll, teams of two to five students will continue to build on ideas.

In addition to developing ideas, Transcend's board has planned many club events to aid the design process and to spark members' imaginations. A panel of professors in the schools or departments from which the students hail review student designs.

Members of Transcend race to build the tallest and most stable tower out of newspaper



Members discuss possible designs for a paper plane competition

The club has already made strides in reaching out to the business community. Entrepreneurs and representatives from start-ups have made presentations on entrepreneurial spirit, and the club plans on hosting several workshops to educate its members. Most notably, the non-profit Three Day Startup (3DS) will serve as a capstone for club members. Three Day Startup is a three-day workshop that takes members of the group through the entirety of the engineering design process in three days. Although some ideas could still be improved upon afterwards, the creative spirit and the drive to fix a problem in three days is truly what Transcend is about. WE

Written by: Brenda McIntire

Photography by: Hassan Abbad

Design by: Lukas Lindquist

SunPower: Coming to a Grid Near You!

Californian solar cell company, SunPower, is harnessing the power of the sun to redefine the energy situation on Earth. Meet the company's CEO for the inside scoop.

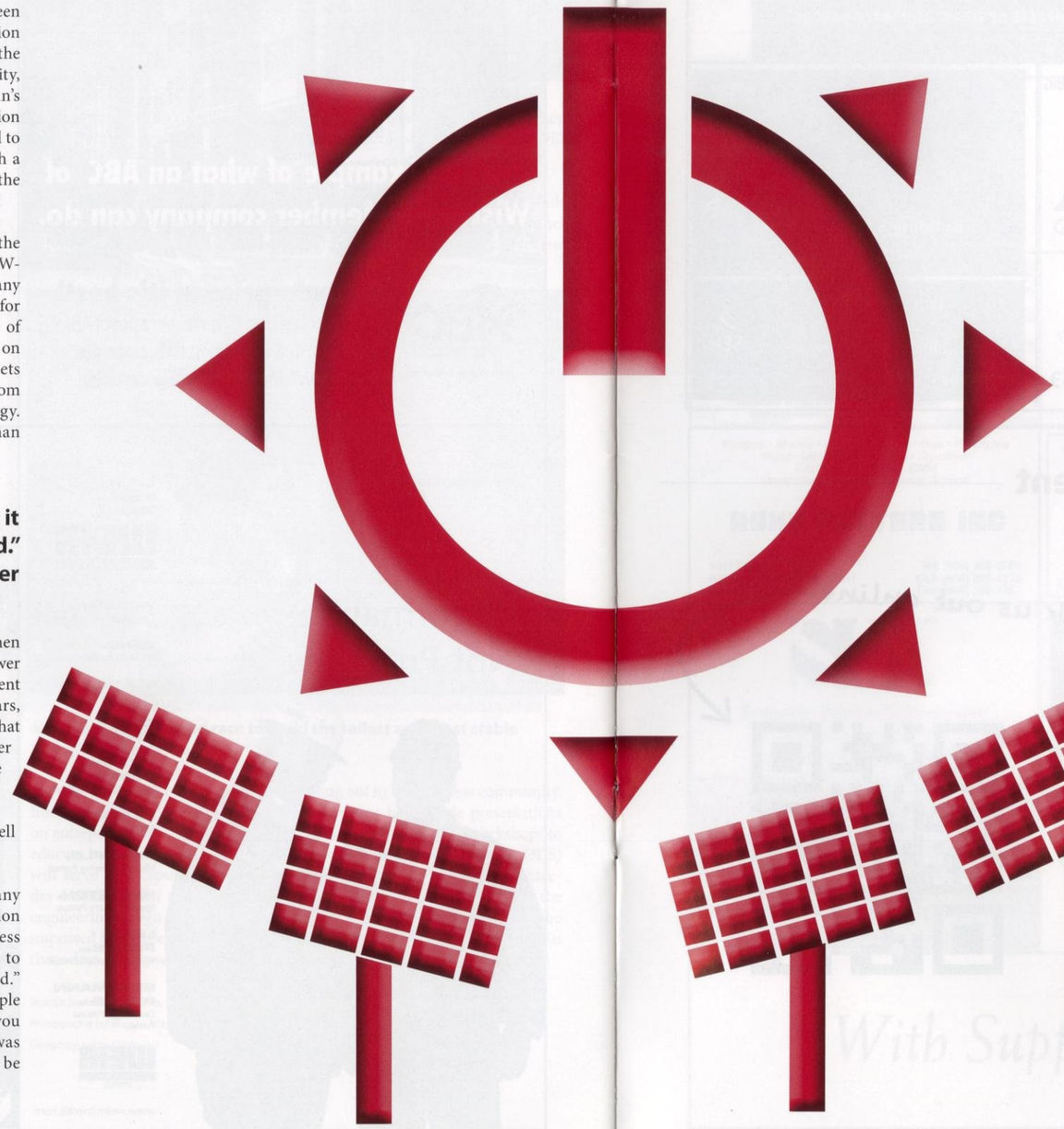
For as long as the planet Earth has been in existence, the sun has been capable of nuclear fusion. Earth, however, has not yet seen the collision of two atomic nuclei to create a heavier atomic nucleus, which is the process known as nuclear fusion. Since we have not yet made fusion a reality, humans have been trying to "fake it until we make it" by harnessing the sun's power. A company based in northern California, SunPower, does its rendition by harnessing that power via solar cells. What makes this company special to UW-Madison is the CEO, Tom Werner. Werner is a Badger at heart with a bachelor's degree in industrial engineering and a determination to change the way the world sees energy.

Visiting campus this past September, Werner shared his insight into the energy revolution and SunPower's mission with a captive group of UW-Madison students and professors. He described SunPower as a company that builds solar cells, and it is focused on turning sunlight into power for both commercial and residential customers. As he passed around one of SunPowers small cells, Werner stated, "This solar cell absorbs sunlight and on the back is metal. Most solar cells have metal on both sides; this is what sets our solar cells apart. Without metal on the front, no sunlight is blocked from being absorbed. This metal on the back carries out excited electrons as energy. So we turn sunlight into energy using silicon. We do it more efficiently than anyone in the world."

"We turn sunlight into energy using silicon. We do it more efficiently than anyone in the world."
-Tom Werner

However, the company was not always at the top of its market. In 2003, when Werner joined the business, solar was a niche market. In 2005, SunPower went public and tripled its revenue in the following three years. Stock went from $18 to a peak of $164. Although business boomed for several years, Werner claimed that "a crash was inevitable, capitalism works," meaning that the explosion of solar opportunities caused a saturated market. SunPower stock went from $164 to a low of $4 in 2012. Werner coined this experience a "profitless-prosperity," meaning that there was a large market but no money could be made. Eventually the competitors were thinned and SunPower weathered the storm to become the most efficient silicon solar cell company in the world.

Not only does SunPower provide a world-class solar cell, but the company also owes much of its success to its employees' determination and passion for making solar energy comparable to conventional energy, regardless of naysayers. Werner stated that "solar cancompete, and that is going to be fundamentally disruptive to the conventional way energyis delivered." In efforts to persuade nonbelievers, Werner uses the example that "Apple sold its first smart phone in 2007, think about that, six years later can you imagine not having a smart phone? In six years the flip phone industry was destroyed. That is what solar is going to do to utility. It is a great time to be in renewable energy."



With the dispute of solar's place in the energy infrastructure cleared up, SunPower is dedicated to providing a one stop shop by selling directly to the customer and producing only the most cost-effective and technically advanced cells. This is done through two strategies. The first, as Werner states, "is to have differentiated technology so SunPower can demand a premium in the market. The second strategy is to sell it through our channels so they can control their own destiny and evolve to be an energy solutions company." In the future, the plan is to have people buy kilowatt-hours from the energy solutions company, that way they are capable of either going off the grid or managing their costs completely from a SunPower solution. The SunPower solution also includes sophisticated systems that place the solar cells at the optimum angle according to the angle of the sun, which is under warranty for 25 years. This is yet another characteristic that sets SunPower apart from its solar competitors.

With so many things going for the company, SunPower has a bright future. However, it is not the only company aiming for the same goals. For example, Solar City, a competitor, is partially owned by Tesla Motors's very own Elon Musk. At this point in time, companies like Solar City and SunPower are the forefathers of solar in today's energy infrastructure. Therefore, it seems as though each company is intentionally egging on other companies in the energy market. This drive is what will redefine conventional energy.

Leaders like Werner, who are capable of changing an era, can provide some valuable advice to the future graduates of UW-Madison. When asked what advice he could give to the magazine readers, Werner said, "The competition of academics is a good proxy for work. You get ahead on merit. So the idea of fighting for a grade or where you rank, thereis a fair amount of inaccuracy in that system, but it does matter because when you go out to your job, you are competing. The more effectively you can compete, the more you move up, the more you get to do what you want, the better expert you are on what you do." Following his first piece of academic advice, Werner provides a real-world tip to students: "My second piece of advice is that the real world is not that simple. There are politics. Whenever you get more than two people together, there are a lot of politics. People do not see things the same way. That is all I do for a living now, is sort out arguments." To get some experience with this prior to entering the "real world," Werner asks students to "think about getting an internship, because the ability to solve something technically is incredibly important, but how you do it in a system of people that are imperfect is the key."

With that being said, the future of solar energy is rapidly approaching, and young minds will be needed to harness the power of the sun. In his closing statements, Werner said "Get a job. Get a job at SunPower." The industry leading company is now hiring for full-time engineers and interns. As a UW-Madison alumnus, Tom Werner is especially looking to hire students from Madison to lead a new era in energy. WE

Written by: Ashley Bredemus
Design by: Brent Grimm

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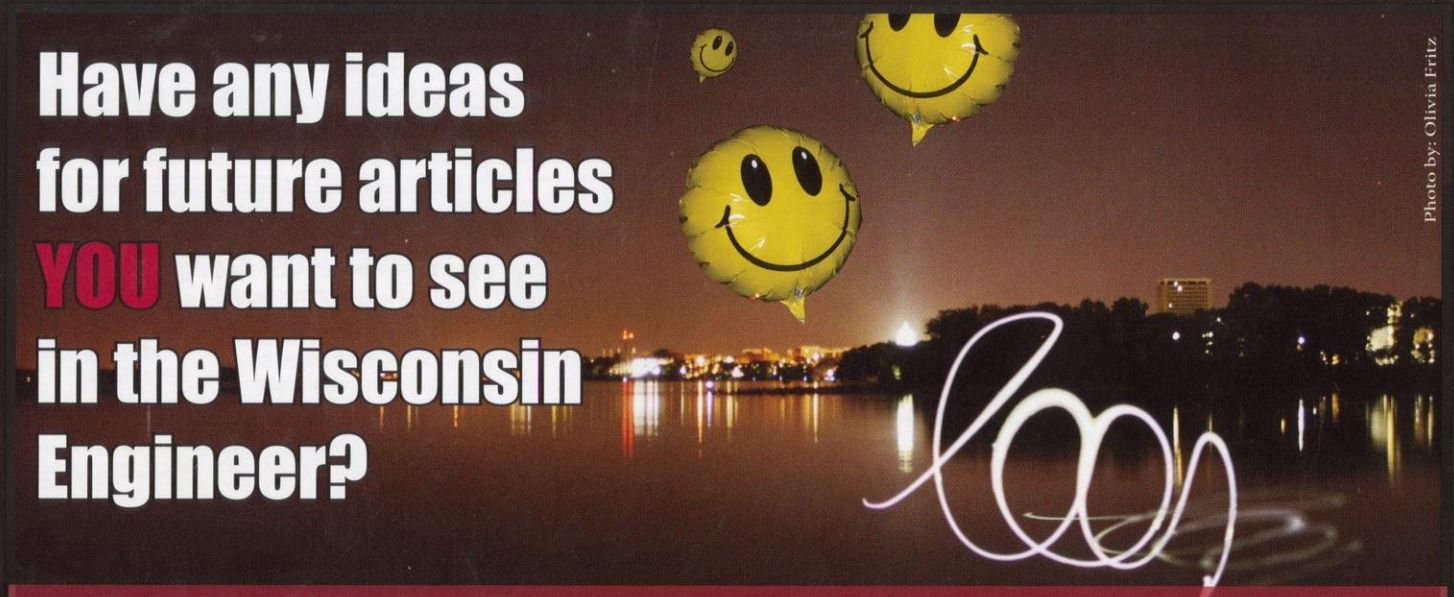

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